SPECIFICATION

PIEZOELECTRIC GENERATOR

TECHNICAL FIELD

The present invention relates to an electric power generator and more particularly to a piezoelectric ceramic electric power generator.

RELATED ART

The ability of a piezoelectric ceramic to generate power upon an impact or application of a similar mechanical force thereto is known to the public. However, the levels of power generated were believed to be small static charges.

PROBLEMS TO BE SOLVED

Lately, as environmental contamination is a serious social concern, energy conservation type power generators such as wind mill power generators or fuel cells have been rigorously developed. A piezoelectric ceramic can obviously generate electric power, even though its output is limited to a very low level. A piezoelectric ceramic capable of generating electricity of a commercial grade would greatly contribute to society.

The present invention is based on experiments conducted repeatedly proving that a piezoelectric ceramic has the capacity of unexpectedly high level output power generation, and is directed to provide a power generation system that favors power generation at-site without requiring a power transmission facility by developing a piezoelectric power generator which is pollution - free and suitable for use at sites where power is required.

MEANS TO SOLVE THE PROBLEMS

To accomplish this objective, the power generation means of the present invention provides an array of elements as a unit of power generation, which is a stack of rectangular thin piezoelectric ceramic elements for use in power generation by means of

bending deformation caused by mechanical pressures, wherein the number of elements is determined such that the number yields the best pressure-deformation efficiency.

Each power generation unit, being repeatedly pressurized by a given mechanical force to cause a given flexure continuously thereof, is capable of stably generating a given level of electric energy.

BRIEF DESCRIPTION OF THE INVENTION

Figure 1 is a diagram illustrating a piezoelectric ceramic element for piezoelectric power generation.

Figure 2 is a perspective view illustrating a basic unit for piezoelectric power generation.

Figure 3 is a perspective view illustrating another basic unit for piezoelectric power generation.

Figure 4 is a perspective view of a part of the piezoelectric power generator of the present invention.

Figure 5 is a cross sectional view of a holding mechanism of the power generation portion of the unit based piezoelectric power generator.

Figure 6 a cross sectional view of another holding mechanism of the power generation portion of the unit based piezoelectric power generator.

EMBODIMENTS

Embodiments of the present invention are described herein with reference to the drawings. Figures 1(A) and 1(B) illustrates a rectangular thin film piezoelectric ceramic element **1** for use in piezoelectric power generation in which metallic electrodes are formed onto both the upper and lower surfaces of the piezoelectric ceramic element **1** by baking or plating a metal having good conductance or the like to a uniform thickness and a configuration closely resembling the outline of the piezoelectric ceramic element in the proximity of but inside thereof. The electrode on the upper surface is designated as (+) electrode **2** and the electrode on the lower surface is designated as (-) electrode **3**.

The rectangular thin film piezoelectric ceramic element **1** is so thin that it tends to flex.

As illustrated in Figures 2(A) through 2(D), a rectangular thin piezoelectric ceramic element **1** is made into an element set **9** as shown more specifically in Fig. 2(C) by attaching a (-) electrode plate **6** on the lower surface thereof and a (+) electrode plate **4** on the upper surface thereof. Multiple element sets **9** are stacked and insulation sheets **8** are inserted between each element set **9** for purposes of stabilization. Insulation sheet **8** is also attached to the top and bottom surfaces of each element set **9** such that the entire assembly provides a piezoelectric element array **10** as is shown in Fig. 2(D).

In Figures 3(B) and 3(C), a multiple number of rectangular thin piezoelectric ceramic elements **1** are flipped alternately such that an (-) electrode plate **6** is inserted between a (-) electrode **3** of one element and a (-) electrode **3** of another element in one element set 9 as indicated in Fig. 3(B) and Fig. 3(C) respectively, with an input terminal **7** oriented to the rear thereof as shown in Fig. 3(D). In addition, a (+) electrode plate **4** is inserted between two adjacent (+) electrodes **2** with an output terminal **5** oriented to the rear of the element **1.** The surface of (+) electrode **2** of rectangular thin film piezoelectric ceramic element **1** which is on top of the element set 9 is covered by (+) spring type electrode plate **4** with insulation sheet **8** placed thereon and having the same shape as the element **1.** The surface of (+) electrode **2** of the flipped rectangular thin film piezoelectric ceramic element **1** which is at the bottom of the element set 9 is pressed onto (+) spring type electrode plate **4**, and an insulation sheet **8** is placed under (+) electrode plate **4**, thereby forming the piezoelectric element array **12** of Figure 3(D).

It should be understood that the output terminal **5** of (+) electrode plate **4** and the input terminal **7** of (-) electrode plate **6** of Piezoelectric element arrays **10** and **12** are arranged in opposite directions.

Piezoelectric element arrays **10** and **12** of this embodiment employ piezoelectric elements of the monomorph type. However, it should be understood that a bimorph type may also be adopted, and for the bimorph type the middle electrode plate should have a connection terminal portion similar to that of the monomorph type.

The width 11, 13 along the rear ends of each of the piezoelectric element arrays **10** and **12** constitute stationary portions which are capable of fully securing each of the piezoelectric element arrays **10** and **12,** in a holding mechanism with each element array defining a basic unit of the piezoelectric power generator of the present invention.

As illustrated in Figures 4, 5 and 6, mounting base **14** of the holding mechanism on which element array **10** or **12** is installed, comprises: a holding jaw portion 15 having a horizontal channel 22 whose depth is equal to the total thickness of either the piezoelectric element array **10** or **12**; and having a conduction circuit space **16** at the deep end of the channel 22 so as to fully house stationary portion **11**, the output terminal **5**, and the input terminal **7**. Output electrical pickup plate **17** of Fig. 5 or output electrical pickup line and input electrical pickup plate **18** of Fig. 6 are arranged in the conduction circuit space **16** and connected to an electrical circuit in a separate compartment (not shown).

The stationary portion 11 and 13 of each piezoelectric element array **10** and **12** respectively is secured within the holding flange portion **15** of mounting base **14**. All of the output terminals **5** are connected to an output electrical pickup plate **17** or output electrical pickup lines installed within conduction circuit space **16** and all input terminals **7** are connected to an input electrical pickup plate **18** or input electrical pickup lines also installed within conduction circuit space **16**.

The power generation portion of the piezoelectric power generator has a movable side, which is the front side of piezoelectric element array **10** or **12**, defined by the free end extension of the stationary portion **11** of piezoelectric element array **10** or the free end extension of the stationary portion **13** of piezoelectric element array **12**. The stationary portions **11** and **13** are secured within the holding jaw **15** of the mounting base 14 so that the piezoelectric element array **10** or **12** is cantilevered. The front side of piezoelectric element array **10** or **12,** defined as a free portion, functions as the power generation portion 19 of the piezoelectric power generator.

As illustrated in Figure 5, the free portion or power generation portion **19** of piezoelectric element array **10** or **12** is pushed up to deform the piezoelectric element array to flex by the vertical movement of pressure element **20** which has a curved pressing surface of a length sufficient to press said free portion, lies parallel to the length direction but has a peak thereof along the center line of the curvature.

Figure 6 shows an embodiment for protecting piezoelectric element array **10** or **12** secured onto mounting base **14** during its bending movements, in which upper jaw curvature guide **21** is provided at the upper edge of the holding jaw portion 15 of the mounting base 14 and has a curved surface of the same length as the free portion and of the same curvature as pressure element **20**.

ADVANTAGEOUS EFFECTS OF THE INVENTION

The present invention configured in the manner described above provides the following advantageous effects.

A rectangular thin film piezoelectric ceramic element **1**, developed for power generation, is so thin that it flexes as an external stress is applied thereto to generate stable electric energy. Moreover, these piezoelectric ceramic elements **1** can be stacked and the stacked elements **1** flex at the same time. Additionally, stacking these piezoelectric element arrays **10** and **12** does not cause an adverse effect on the easy-to-flex characteristic thereof as long as thin plates having good conductance are adopted. Hence, electric energy generated by each of the piezoelectric elements can collectively generate electric power.

Piezoelectric element arrays **10** or **12** is cantilevered with stationary portions **11** or **13** along one edge at the rear side thereof being held secured within holding jaw **15** of mounting base **14**, and the free portion **18** at the front side thereof continuously repeats its flexure motion, as pressure element **20** moves up and down, along the curvature of its curved pressing surface; the pressing surface has the same length as the free portion **18**, lies parallel to the length direction of the free portion **18**, and has a curvature peak on the center line in a width direction.

At this time, the use of spring type electrode plates at the top and bottom of piezoelectric element arrays **10** and **12** allows the top and bottom plates to recover from flexure caused by the up and down movement of pressure element **20**.

With the assistance of upper curvature guide **21** which is provided on top of holding jaw portion **15** of the mounting base **14**, when piezoelectric element array **10** or **12** flexes according to the vertical movement of pressure element **20,** the degree of flexure of piezoelectric element arrays **10** and **12** is limited by the curved pressing surface of pressure element **20** and the curved surface of upper curvature guide **21** having the curvature as that of the pressure element. As a result, flexure is uniformly generated without creating spikes of the degree of flexure at specific points, thereby preventing the plates from local destruction derived from exhaustion thereof, thus enabling stabilized power generation.

Note that when pressure element **20** makes a downward movement, upper curvature guide **21** can be called a lower curvature guide, because the upper curvature guide **21** is at the lower end of holding jaw portion **15** of mounting base **14**.